[WO 2004/017266] [PCT/DE2003/002466]

MARKED UP COPY OF SPECIFICATION

STÖBER - W1.1931 PCT-US

DEVICE AND METHOD FOR INSPECTING MATERIAL

CROSS-REFERENCE TO RELATED APPLICATIONS

[001] This patent application is the U.S. national phase, under 35 USC 371, of PCT/DE2003/002466, filed July 22, 2003; published as WO 2004/017266 A1 on February 26, 2004 and claiming priority to DE 102 34 084.6, filed July 26, 2002, the disclosures of which are expressly incorporated herein by reference.

FIELD OF THE INVENTION

[002] The present invention is directed[relates] to an arrangement and to a method for inspecting material [in accordance with the preamble of claim 1 or 12]. A sensor device received light from an illumination device that includes several light sources that emit inspection light.

BACKGROUND OF THE INVENTION

[003] Material inspecting[Such] arrangements are used, although[but] not exclusively, for inspecting printed sheets which have been imprinted with, for example, securities[, for example]. In this connection, the sheet-shaped material is illuminated by the use[means] of an inspection light emanating from an[the] illuminating device, and wherein the inspection light is either reflected at the surface of the material, in so-called [(]incident light inspections[)], or shines through the material, in so-called [(]transmitted light inspections[)]. The inspection light is subsequently recorded by a sensor device, such as, for example, a camera, and the input signals detected in the course of this inspection are evaluated in an evaluating unit.

[004] An arrangement for use in inspecting sheet-shaped material is known from WO 01/85586 A1. Two illuminating devices and two sensor devices are provided in[by] this prior arrangement, which devices are respectively assigned to each other. The first illuminating device is arranged, with respect[relative] to its[the] assigned sensor device, in such a way that the

inspection light falls through the sheet- shaped material, so that a transmitted light inspection is made possible. The[But the] second illuminating device is arranged, with respect[relative] to its[the] assigned sensor device, in such a way that the inspection light from the second illuminating device is reflected by[at] the material, so that an incident light inspection is made possible. As a result, it is therefore possible to perform both an incident light inspection and a transmitted light inspection of the material to be inspected.

[005] DE 44 34 168 A1, EP 0 952 438 A2, JP 10-185 690 A and USP 3,120,782 all disclose arrangements for use in inspecting material by the provision[means] of a sensor device and of several light sources. The[, wherein the] light sources each respectively emit an inspection light of a different color[s] of the light.

[006] GB 2 002 923 A and DE 15 12 179 B1 both show arrangements of light sources for the provision of incident light and of transmitted light.

SUMMARY OF THE INVENTION

[007] The object of the present invention is directed to[based] on providing an arrangement and a method for inspecting material.

[008] In accordance with the present invention, the object is attained by the provision of an arrangement for inspecting materials that includes a sensor device and an illumination device. Inspection light is emitted from the illumination device from several lights sources, is received by the sensor device, and is evaluated in an evaluation device. The illumination device has at least two light sources that each emits an inspection light which is colored differently from the light from other ones of the illumination device. The sensor has at least two color channels that are matched to the different inspection lights. Both incident light inspections and transmitted light inspections can be accomplished separately, yet at the same time [means of the characteristics of claims 1 or 12].

[009] A particular advantage of the present invention lies in that only one sensor device[is required], such as, for example a color camera, a color line camera or a CCD camera, is required for being able to check various testing

criteria by use[means] of the subject arrangement. In this case, the present invention rests on the basic idea that the different testing criteria are checked by the use[means] of light of different colors. Therefore, the illumination device has at least two light sources, each of which emits an inspection light of a different light color, i.e. of a different wave length. At least two different color channels are provided in the sensor device. It is possible by the provision[means] of this arrangement to record lights of different colors using[with] the sensor device, which different colored lights can then be separately evaluated in the evaluation unit. The input signals recorded by the sensor device can each be processed separately from[of] each other in accordance with the respective color of light by use[means] of the different color channels in the sensor device so that, while[in spite of] using only one sensor device, the different testing criteria are not mixed up.

[010] It is particularly advantageous, in accordance with the present invention, if the light sources each emit an inspection light of a substantially monochrome light color. These monochrome light colors can be assigned, in a

simple way, to the different color channels of the sensor device. The result is[, so] that an unintentional distortion or influencing of the input signals, in the different color channels, is essentially prevented.

[011] The spectral position and/or the band width of the inspection light emitted by the light sources is matched to the transmission curve of the sensor device.

[012] Commercially available color cameras, which can be used as sensor devices in the [proposed] arrangement in accordance with the present invention, customarily have three separate color channels for the colors red, blue and green. It is therefore particularly advantageous for[if] the illuminating device to have[has] three light sources, whose inspection lights are[light is] matched to the respective properties of the three color channels. Three light sources, with the three monochrome light colors red, blue and green, for example, can be used for this purpose.

[013] The arrangement of the present invention offers particular advantages if the light sources are arranged in different positions relative to the

material that is to be inspected. As[It is possible as] a result, it is possible to check different testing criteria by [means of] this arrangement of the lights sources in different positions, which correspond to the respective desired positions, while only a single sensor device must be provided.

[014] In order to be able to adapt the arrangement of the present invention to different inspection purposes, it is particularly advantageous if the light sources are displaceably supported or seated. This means that, by displacing the light sources, it then becomes possible to adapt the different light sources to different testing criteria.

[015] In accordance with a preferred embodiment of the present invention, one light source has been arranged in such a way that the inspection light shines through the [respective] material to be inspected. Moreover, a second light source has been arranged in such a way that the respective inspection light from this second light source is reflected by the material to be inspected. As a result, it is possible to achieve, that by this [that by means of the] arrangement, an incident light inspection, in which[wherein] the inspection light is reflected by the material,

can be performed simultaneously with a transmitted light inspection, in which[wherein] the inspection light falls or passes through the material.

[016] Only one sensor device is required for this combined incident light and transmitted light inspection. The[, because the] incident light inspection is processed in a first color channel, while[and] the transmitted light inspection is processed in a second color channel.

[017] Alternatively, or in addition to this first preferred embodiment, it is also possible to arrange two light sources in such a way that the different colored inspection lights are both reflected, at different angles, by the material that is being inspected. With this second preferred embodiment, [too,] the input signals formed[created] by the inspection light in the sensor device are processed in different color channels, so that different testing criteria can be recorded and processed with the use of only a single sensor device.

BRIEF DESCRIPTION OF THE DRAWING

[018] A preferred[An exemplary] embodiment of the present invention is

represented in the sole drawing figure[drawings] and will be described in greater detail in what follows.

[019] The sole[single] drawing figure shows, in a schematic cross section, an arrangement for testing sheet-shaped material in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[020] The device for inspecting material, indicated generally at[arrangement] 01, [represented] in the sole drawing[s] figure includes[has] a sensor device 02, which is embodied as a color line camera, three light sources 03, 04, 06, which together form an illumination device, and a support 07.

[021] The material 08 to be inspected, which material may be, in particular, a sheet- or a web-shaped material 08, is introduced into the arrangement 01 by the use[means] of suitable conveying arrangements, which are not specifically represented, and then lies flat on a[the] top surface of the support 07. A recess or an aperture 09 is provided in the support 07, so that inspection light 12 emitted by

a light source 06, which is arranged underneath the support 07, can fall into or be received in a[the] lens of the sensor device 02. The first light source 03 emits inspection light 10 of the first monochrome light color red. The second light source 04 emits an inspection light 10 of the second monochrome light color blue. The third light source 6 emits the inspection light 12 of the third monochrome light color green. The sensor device 02 has three separate light channels for the light colors red, blue and green.

[022] The process of the inspection of the image information, in particular the print image, of the material 08 is performed as follows. After the material 08 has been arranged above the recess or aperture 09, the three light sources 03, 04 and 06 simultaneously each emit their respective inspection light 10, 11 and 12 in the different light colors. The first, red inspection light 10 and the second, blue inspection light 11 are reflected at different angles at the surface of the sheet-shaped material 08 and together fall into or are received in the lens of the sensor device 02. As a result, it is thus possible to perform an angle-dependent incident light inspection of the sheet-shaped material 08. Simultaneously, the third, green

inspection light 12 emitted by the third light source 06 falls or passes through the sheet-shaped material 08 and also into the lens of the sensor device 02. In this way, it is possible, simultaneously with the two incident light inspections accomplished by [means of] the first and second light colors red and blue, to perform a separate transmitted light inspection by use[means] of the third light color green. The assignment of the three different light colors to the two different incident light and to the transmitted light inspections is basically arbitrary and can be interchanged.

[023] The first, second and third inspection lights 10, 11 and 12 corresponding to the first, second and third different light colors red, blue and green, respectively, are processed in the sensor device 02 in separate color channels and are passed on to an evaluating device, which is not specifically represented. The[Therefore the] image contents of each of the individual color channels can be processed separately from[of] each other in the evaluation unit. However, it is, of course, also possible in accordance with the present invention[here] to bring the input signals received on the separate color channels

into correlation with each other in order to be able, for example, to draw spatial conclusions.

[024] While a preferred embodiment of a device and method for inspecting material, in accordance with the present invention, has been set forth fully and completely hereinabove, it will be apparent to one of skill in the art that various changes in the specific image to be inspected, the specific structure of the support and the like could be made without departing from the true spirit and scope of the present invention which is to be limited only by the following claims.

WHAT IS CLAIMED IS:

[List of Reference Numerals]

[O1 Arrangement
02 Sensor device
03 Light source
04 Light source
05 -
06 Light source
07 Support
08 Material, sheet-shaped
09 Recess
10 Inspection light, red
11 Inspection light, blue
12 Inspection light, green]